The Cave Environment

Context

Since early times, caves have been places of mystery, art, accommodation and adventure. For students, they still hold some of these fascinations. In this unit the Cave environment is used to investigate the geology of limestone, chemistry of calcium carbonate, the environmental impacts of mining limestone for cement and the impacts of human visitation on caves. Caves contain a rich fauna that can essentially be treated as a closed system for investigation, the energy input into the cave consists mainly of guano from the bats and debris brought into the caves via extreme events like flooding. This topic provides the opportunity for visits to cave systems with guided tours provided by the Department of Tourism and field work investigating the geomorphology of areas covered by soluble rock. Caves in Australia have been essential in the science of palaeontology, providing fossil evidence for past environments and fauna. Riversleigh and Naracoorte are two examples of cave environments that have trapped fossil evidence of a particular time in the past.

Major syllabus references

Prescribed Focus Areas:	**Models, theories and laws**:	**Skills**:	**Values and attitudes:**
Nature and practice of science	Evolution and Natural Selection 5.8.3 a, b.	5.14	5.25, 5.26, 5.27.
Describes the processes that are applied to test and validate models, theories and laws. 5.2 a, b	**Structures and systems:**	5.15	
	Compounds and reactions 5.7.3 a, b, c, e	5.16	Possible student project
	Natural events 5.9.4 a, b, c.	5.17	
Implications of science for society and the environment	**Interactions:**	5.18	
	Ecosystems 5.10 a, b, c, d.	5.22	
Discusses evidence supporting different viewpoints 5.4 c, d, e	Resources 5.11.1 b. 5.11.2 a.		

Approaches to learning and teaching

Students gather information about the various aspects of the cave environment. They perform practical activities on cave chemistry, identification of limestone and the fossils it contains, and practical activities related to the human uses of limestone in cement, agriculture and industry. The activities support various teaching strategies including group work, teacher led instruction or a stations approach. Access to the Internet and the library would be a benefit to the learning in this topic as would the opportunity for an excursion to limestone caves and cement mining areas. The topic could conclude with the preparation of a script for a cave guide to give to a school group on a tour.

Key references

Science in Perspective Book 4 p333-336; http://www.ucmp.berkeley.edu/fosrec/TimeScale.html; Fossils and dating http://www.ucmp.berkeley.edu/fosrec/BarBar.html; Wind cave
http://www.nps.gov/wica/speleoth.htm; Sinkholes http://emerald.ucsc.edu/~jsr/EART10/Trips/FT2/sinkhole.html; Hazards of karst
http://www4.wittenberg.edu/academics/geol/progcrs/geol220/porter/index.shtml; Equilibrium in caves http://chemlinks.beloit.edu/modules/caves_progress.html; Kentucky caverns
http://www.kdu.com/chem.html; Mining and uses http://www.continentallime.com/lime.html; Biospeleology
http://www.utexas.edu/depts/tnhc/.www/biospeleology/photos.htm;
http://www.umsl.edu/~joellaws/ozark_caving/mss/cavefish.htm; http://wasg.iinet.net.au/clife.html; http://www.saske.sk/cave/slkslkzool.html; Cave links
http://www.cancaver.ca/bio/biolinx.htm; Chemlinks http://chemlinks.beloit.edu/modules/caves_progress.html; Video "*Message in the Rocks*" UNSW Syd 1997
Chemtext, Alexander Boden, (Science Press, 1986, p486); CD: *Resources Working for the Right Balance* (NSW Minerals Council)

Specific content outcomes By the completion of this unit of work students should be able to:	Teaching ideas and strategies	Resources	Assessment strategies
5.9 relate the development of the universe and the dynamic structure of Earth to models, theories and laws and the influence of time	**LIMESTONE** • Write detailed descriptions of at least 5 samples of limestone (5.14) • Test limestone with acid and write a general word equation for reactions of acid with carbonate • Predict the likely environments in which limestone will form	Communication	Write a brief history of the formation of limestone
5.9.4 natural events to: b) describe conditions under which fossils form	• Identify some common fossils likely to be found in limestone and describe how they form	*Science in Perspective* Book 4 p333-336 (Use	
c) relate the fossil record to the age of Earth and the time over which life has been evolving	• Create a geological time scale to a scale similar to 1mm=1MY and locate on it the major events in earth history • Identify times in the geological time scale where various fossils can be found (including index fossils) and write them on the scale • Investigate the fossil finds at Riversleigh and Narracoorte and discuss how they were formed and what they tell us about the past environment of Australia	Problem solving	
a) identify that geological history can be interpreted from the formation, by sediments, of horizontal layers in which the oldest are at the base and the youngest at the top.	• Observe some geological maps and interpret the limestone history from the map • Investigate the processes by which limestone can turn to marble (eg contact and regional metamorphism)	*Science in Perspective* Book 4 p314-318 Geological mapping	

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5.16 accesses information from a wide variety of secondary sources 5.17 explains trends, patterns and relationships in data and/or information from a variety of sources	**CAVES** • Students use the library and Internet to collect information on cave creation, structures and decoration. Students present information to the class on computer, on a poster or verbally. (5.18 b, c.)	Internet reference: Wind Cave tour Wombeyan, Jenolan or other local suitable cave environment	Computer, poster or verbal presentation
5.10 assesses human impacts on the interaction of biotic and abiotic features of the environment 5.10 ecosystems to: a) distinguish between biotic and abiotic features of the local environment	**Environmental Factors of Caves** • Students predict, identify and if possible measure the abiotic factors of the cave environment: o air flow o water flow o light o pH o salts o temperature		
b) describe the importance of cycles of materials in ecosystems 5.8.3 the theory of evolution and natural selection to: a) discuss evidence that present day organisms have developed from different organisms in the distant past b) relate natural selection to the theory of evolution	• Students identify the biotic factors of the cave environment by collecting photos of cave fauna and presenting them in either a computer presentation or poster showing the cycles of food • Students should use the theory of evolution by natural selection to explain the adaptations of the organisms to the cave environment : o vertebrates (eg bats) o invertebrates (eg insects) o microorganisms (eg fungi) o guano o debris	Internet reference: Biospeleology	Computer or poster presentation

Specific content outcomes By the completion of this unit of work students should be able to:	**Teaching ideas and strategies**	**Resources**	**Assessment strategies**
5.7.3 compounds and reactions to: a) identify that a new compound is formed by rearranging atoms rather than by creating matter b) classify compounds into groups based on common chemical characteristics c) construct word equations from observations and written descriptions of a range of chemical reactions e) qualitatively describe reactants and products in the following chemical reactions: i. combustion ii. corrosion iii. precipitation iv. acids on metals and carbonates v. neutralisation vi. decomposition 5.14 undertakes first-hand investigations independently with safety and competence 5.17 explains trends, patterns and relationships in data and/or information from a variety of sources	**Chemistry of caves: crystallisation / recrystallisation** • Students dissolve excess samples of powdered limestone in weak acid and then filter and allow to evaporate. Students should identify the chemical change and the physical change in the reaction • Students write generic equation for: Acid + Carbonate ⟶ Salt + CO_2 + Water • Acidity of carbon dioxide in water. (Students are posed the question about what causes limestone to dissolve. They should come to the conclusion that it is the air/rain, how can the air be acidic?) • Students identify acidic neutral and basic calcium compounds • Students test the pH of distilled water with universal indicator then using a drinking straw bubble breath containing CO_2 and watch the formation of carbonic acid as the indicator changes • Students write a description of how rain can dissolve limestone • Students investigate the history of cement. They will: ❖ Discuss the carbonate / oxide and hydroxide reactions to create lime from $CaCO_3$ ❖ Heat powered calcium carbonate to make lime. ❖ Add drops of water to lime to make slaked lime and add it to water to make limewater ❖ Students design a reaction pathway chart ❖ Mix up slaked lime with sand to make mortar and observe reaction over two days ❖ Discuss how cement is a mixture of	Internet reference: Equilibrium in caves Internet reference: Chemlinks Visit Berrima Cementworks Internet reference: Mining and Uses or Use description in *Chemtext* p486 Library	Practical report Report on visit to cement works Report on library research of the history of cement Reaction pathway chart

	limestone clay and gypsum which has been made into a slurry, heated and dried		

Specific content outcomes By the completion of this unit of work students should be able to:	**Teaching ideas and strategies**	**Resources**	**Assessment strategies**
5.11 analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining Earth's resources. 5.11.1 b) identify properties that make some natural resources economically important and describe their uses 5.11.2a) relate pollution to contamination by unwanted substances 5.10 ecosystems to: c) describe some impacts of human activities on ecosystems d) discuss strategies used to balance human activities and needs in ecosystems with conserving, protecting and maintaining the quality of the environment	**Environmental Impacts** **Mining** • Students research the reasons for mining of limestone caves (including Guano mining and agricultural lime) and discuss the environmental impacts that could be caused by mining • Students plan a mining project on CD ROM and discuss the rehabilitation of the site **Tourism** • Students plan a visit to a cave and write a script for a cave guide to give on the tour • Students discuss the issues related to balancing the human activity in the caves with the need to maintain the quality of the cave environment. • Students prepare a brochure for a cave guide to give out explaining the main features of the cave environment	CD: *Resources working for the right balance* (NSW Minerals Council) Visit to a limestone mine and observation of the rehabilitation works/ plans for the site Internet reference: Mining and uses Literacy in science	Script for a cave guide Brochure showing the main features of the cave environment.